# Welded Wire Fabric Reinforcement for Asphaltic Concrete

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This report evaluates the use of welded wire fabric reinforcement to alleviate rutting and/or shoving of pavement at intersections, and compares the effectiveness of extra thickness of asphaltic concrete overlays over portland cement concrete vs the use of welded wire reinforcement in the asphaltic concrete overlay to control reflection cracking in the asphaltic concrete surface. The advisability of breaking the old concrete pavement into small slabs is also analyzed. It is shown that the stability of the asphaltic concrete surface course has been increased by reinforcing with welded wire fabric reinforcement and that a considerable reduction in the amount of pavement distortion has resulted at the intersections investigated. It is also shown that, although welded wire fabric reinforcement has not demonstrated ability to prevent or reduce reflection cracking, breaking of the existing rigid pavement has prevented or at least retarded reflection cracking.

## I. Welded Wire Fabric Reinforcement to Alleviate Rutting and/or Shoving of Pavements at Intersections

● ONE OF THE MOST perplexing pavement conditions that exists is the rutting and shoving of flexible pavements which often occurs at bus stops or other similar areas where buses and heavy trucks frequently brake. Such a condition is not only disturbing to the motoring public but requires costly maintenance.

In July 1956 an experimental paving section using a 6 x 3 - 10/10* welded wire fabric reinforcing in the surface course was constructed on an old viaduct in Jacksonville in an attempt to alleviate such pavement conditions. This section was in constant use for three years after its construction without apparent distortion while adjacent sections of the pavement continued to distort.

It appeared that the fabric in this experimental section had contributed to the stability of the asphaltic concrete surface course; but, inasmuch as no control sections were constructed of similar material without the fabric, there was no way to definitely state just how much effect the wire had on the stability of the pavement (1).

The results of this initial study led to a more complex experimental program on the use of welded wire fabric reinforcing in asphaltic concrete. Two city street intersections were selected on Kings Road (US 1) in Jacksonville as locations for the test sections of this program. These test sections were constructed in June 1959 during the resurfacing of Kings Road. Figure 1 shows a typical section of this roadway at these intersections. In one approach lane at each of the two intersections, 150 lineal feet of 6 x 3 - 10/10 welded wire fabric reinforcement was placed immediately below a $1\frac{1}{2}$-in. asphaltic concrete type I surface course (2). The fabric was placed on Kings Road in

*The size of welded wire fabric reinforcement is expressed by four dimensions: the spacing of the longitudinal wires (in inches), the spacing of the transverse wires (in inches), the gage (U.S. Steel Wire Gage) of the longitudinal wires, and the gage of the transverse wires (U.S. Steel Wire Gage).

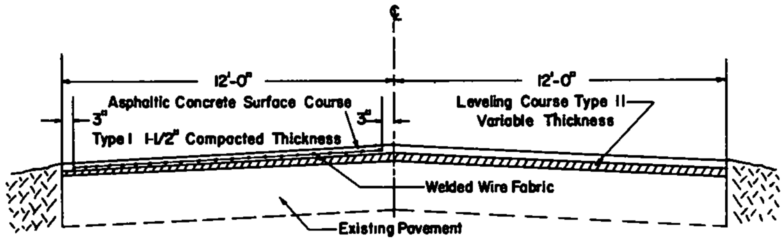



Figure 1. Typical transverse section of roadway at test sections.

the south approach lane at Tyler Street, and in the north approach lane at Pearce Street. The north approach lane at Tyler Street and the south approach lane at Pearce Street were used as control sections.

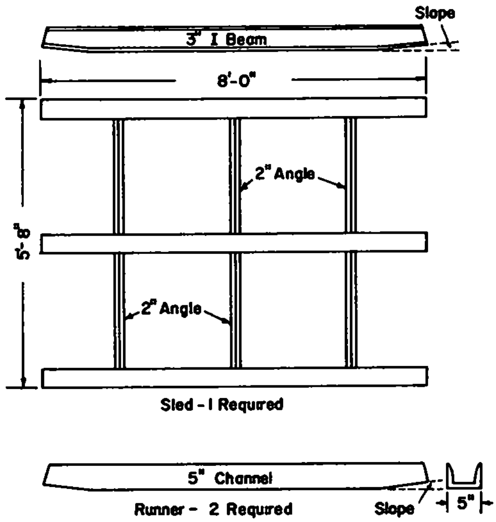



Figure 2. Hold-down device.

## PROCEDURES

Construction procedures were essentially in accordance with the recommended practices offered by the Wire Reinforcement Institute (3) with the exception that the recommended $1\frac{3}{4}$-in. minimum overlay was reduced to $1\frac{1}{2}$ in. because this is the maximum normal thickness used by the Florida State Road Department.

The fabric was delivered to the experimental test sites in rolls measuring 11 ft 6 in. in width and 150 ft in length. It was placed, with the transverse wires down, on the leveling course so that the 3-in. spaced wires were at right angles to the line of pavement, and the 6-in. spaced wires parallel to the centerline. A $1\frac{1}{2}$-in. asphaltic concrete type I surface course was placed over the fabric with a Barber-Greene finishing machine.

A hold-down device was attached to the finishing machine to keep the fabric flat against the underlying pavement and to prevent any entanglement of the fabric with the spreader screw. The hold-down device consisted of runners on the outside of each "cat" track and a sled between the "cat" tracks (Fig. 2). The runners and sled were secured to the front end of the finisher by chains (Fig. 3).

Staples were used to secure the starting end of the fabric to the leveling course. The $1\frac{1}{2}$-in. staples used were not completely satisfactory; however, the finisher was able to pave over the fabric at both intersections without incidence, and subsequent inspections of the pavement indicated that the poorly secured starting ends of the fabric were of little significance to this experiment.

Tension was applied to the trailing end of the fabric by means of J-hooks spaced 12 in. apart and a bridle fabricated from a piece of pipe and three sections of chain. This device is shown in Figure 4.

### Tyler Street Intersection

Installation of the fabric was made first at the Tyler Street intersection. The fabric was delivered rolled with the transverse wires in (towards the center of roll). Because recommended procedures (3) for installation suggested that the transverse wires be placed down, the fabric could not be simply unrolled or the transverse wires would be up. Therefore, the roll of fabric was manually placed in the lane to be reinforced.

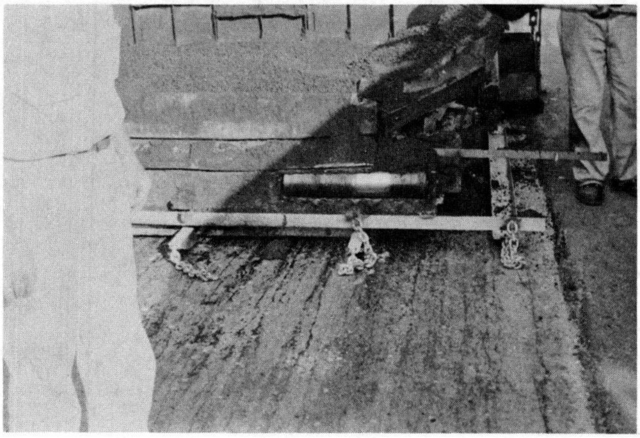


Figure 3. Hold-down device being positioned beneath finisher.

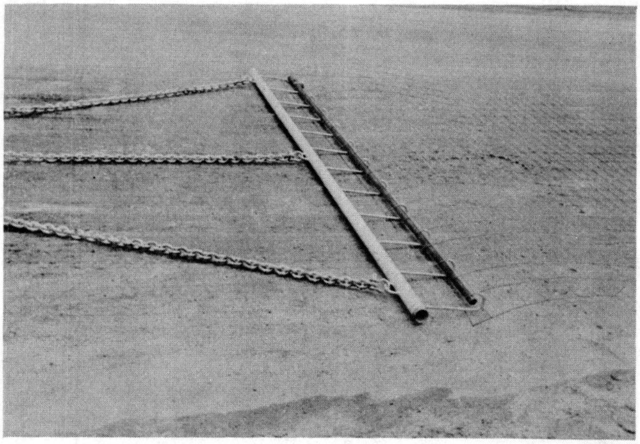


Figure 4. Bridle and J-hook device used for tensioning.

When the wire was properly positioned it was noted that the edge of fabric closest to the centerline was longer than the outside edge of fabric. This caused a series of humps or waves to develop in this longer edge. This wave action in the fabric is shown in Figure 5.

It was not possible to apply sufficient tension to make the fabric lay flat because the applied tension caused the unrolled fabric to curve due to the longer inside edge. The tension was released and paving began. While paving over the fabric, bulges that developed in front of the finisher were partially eliminated by the use of a crimping tool, as shown in Figure 6. When the wave action of the inside edge became excessive, the fabric was cut from the inside edge towards the outside edge and was cut only enough to permit it to lay flat by lapping the fabric at the cut.

During the initial rolling, wire fabric came through the surface course in several places along the longer edge of the fabric. The surface course material was removed in these areas, the fabric crimped or removed, and the surface course material replaced and rerolled.

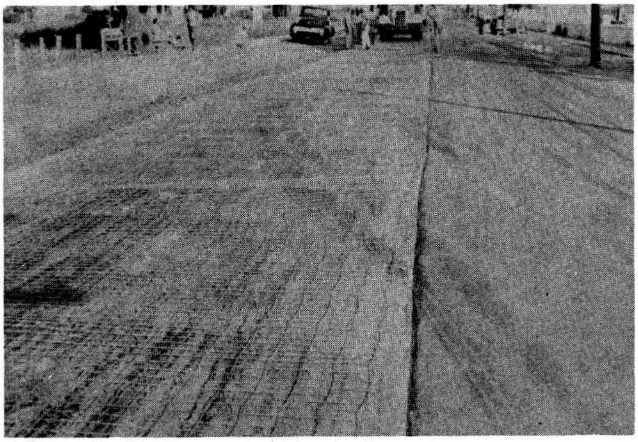


Figure 5. Fabric reinforcement in approach lane before placement of surface course. Note bulging along edge of fabric nearest centerline of pavement.

Figure 6. Using crimping tool to eliminate bulges in wire fabric.

## Pearce Street Intersection

At the Pearce Street intersection the roll of fabric was placed on a spindle to facilitate its proper placement on the pavement. The fabric again had one edge longer than the other and, like the Tyler Street intersection, the longer edge was placed adjacent to the centerline of the pavement. The roll of fabric was cut into four smaller sections and the ends of these smaller sections were lapped with the trailing end of one section placed over the starting end of the next section. This permitted the fabric to lay flat against the pavement and prevented most of the bulging over the longer edge of the fabric similar to that which had occurred at the Tyler Street intersection. Only the initial starting end of the fabric was stapled to the pavement. The finishing machine was stopped about every 20 ft to allow proper crimping of the fabric that had bulged in front of it. More crimping was done in this section than at the Tyler Street intersection and no damaged pavement was found after rolling.

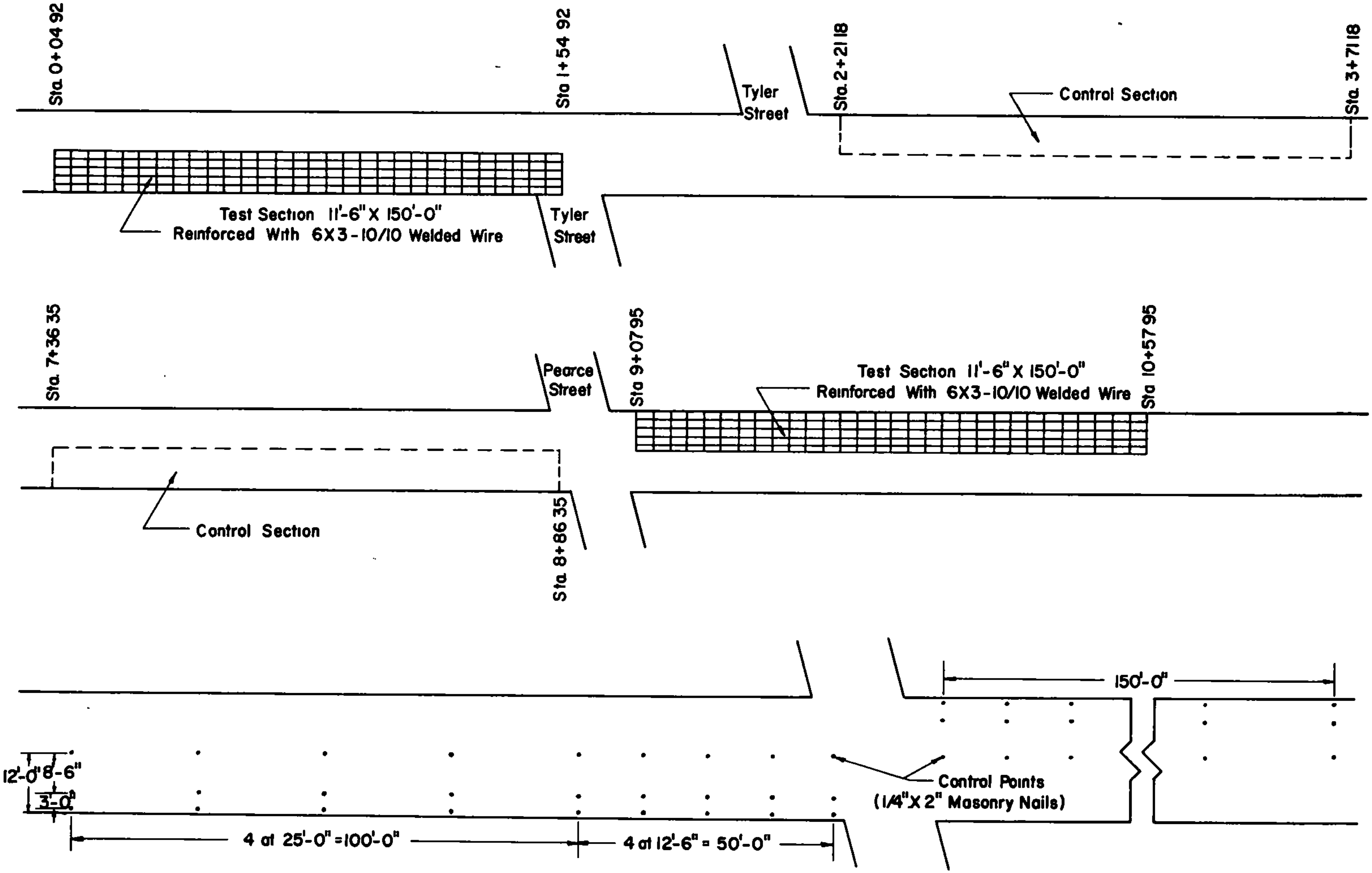



Figure 7. Plan view of test sections with typical layout of control points.

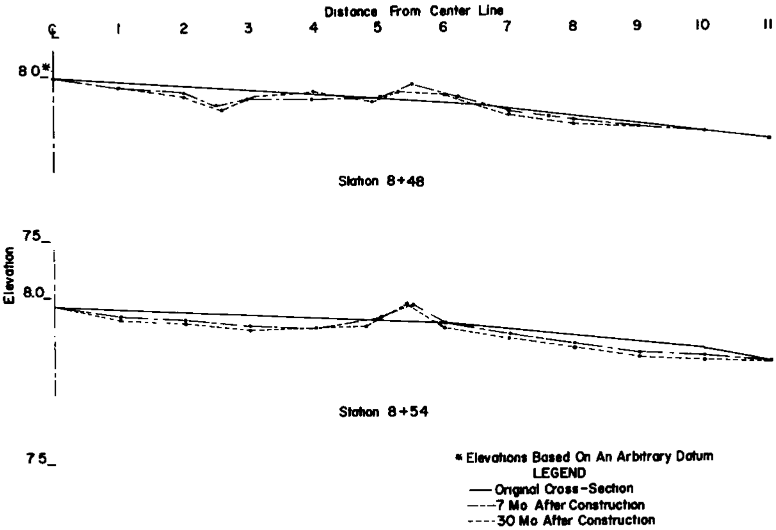



Figure 8. Distortion of Pearce Street section without reinforcement.

## Controls for Evaluation Purposes

Immediately after construction special masonry nails were placed as control points in both approach lanes at each intersection in order to determine horizontal movement of the surface course. The nails were accurately spaced and aligned as shown in Figure 7.

Cross-sections were made at the stations where the nails were placed to measure the extent of any rutting that might develop. Elevations were recorded to the nearest 0.01 ft at 1-ft intervals across the width of the approach lanes.

# RESULTS

## Twenty-Four Hours After Construction

During the first 24 hours after construction, the pavement in the reinforced section at the Tyler Street intersection began to crack, leaving the fabric exposed along portions of the inside edge. A pattern of fine cracks, similar to the pattern of the fabric, was also noted in some areas. This was caused by the fabric having bulged under the surface course in areas, which resulted in a "springy" portion of pavement, and by the traffic creating excessive deflections. The greater part of the cracking, and all exposed wire was near the centerline where the longer edge of fabric had been placed during construction.

No indications of pavement cracking was found in the reinforced section at the Pearce Street intersection, but one small strand of wire was exposed.

## One Week After Construction

Within one week after construction, cracking of the pavement was noticeable in both reinforced sections over the longer edge of the fabric. The pattern cracking in the "springy" areas at the Tyler Street intersection was more pronounced by this time and a probe into these areas revealed a void space between the surface course and the leveling course. This indicated that the fabric was not flat against the pavement and that the bridging effect of the fabric prevented the surface course from bonding to the leveling course.

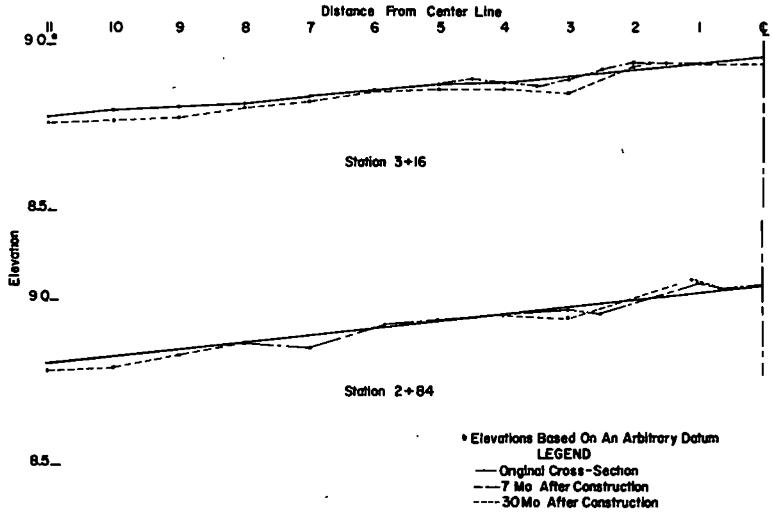



Figure 9. Distortion of Tyler Street section without reinforcement.

## One Month After Construction

The longer edge of fabric caused both reinforced sections to continue to crack and repairs were necessary in these sections one month after construction. The Tyler Street section required patching of the pavement where the wire was protruding and/or the surface course had shattered. At the Pearce Street section only sand sealing of cracks in the pavement was needed.

While repairing the pavement, it was noticed that in some areas dust and water had seeped into the pavement through the cracks to the fabric, but in other areas some fine cracks which had been noted shortly after construction had disappeared, evidently closing under the kneading action of traffic.

## Five and Seven Months After Construction

After five months of service no significant difference with respect to rutting or shoving could be found between the sections with the fabric and those without it. However, by the seventh month after construction severe pavement movement was noticeable in the sections without the fabric. Cross-sections were made at this time of the reinforced sections and the sections without the fabric. These cross-sections when compared with the original cross-sections indicated that excessive distortion of the pavement had occurred in some areas of the sections without the fabric, though no significant changes could be found in the sections with the fabric.

## Thirty Months After Construction

Cross-sections were made again after 30 months of service. These cross-sections also indicated that no significant changes could be found in the reinforced section, but that the sections without the fabric continued to distort. Figures 8 and 9 show typical areas where excessive pavement distortion had occurred in the sections without the fabric.

Table 1 gives the total distortion for all sections after 7 and 30 months of service. The total distortion in the sections without the fabric was approximately twice that in the reinforced sections.

TABLE 1

VARIATION IN TRANSVERSE PROFILE

| Street | Variation (in./in. x $10^{-3}$) | | | |
|---|---|---|---|---|
| | 7 Months of Service | | 30 Months of Service | |
| | Reinforced | Nonreinforced | Reinforced | Nonreinforced |
| Tyler | 5.35 | 7.88 | 5.89 | 9.25 |
| Pearce | 3.64 | 8.28 | 4.06 | 8.78 |

TABLE 2

HORIZONTAL DISPLACEMENT OF CONTROL POINTS IN OWP OF SURFACE COURSE

| Distance from Intersection (ft) | Displacement[1] (in.) | | | |
|---|---|---|---|---|
| | Tyler Street | | Pearce Street | |
| | Reinforced | Nonreinforced | Reinforced | Nonreinforced |
| 0 | -.156 | -.156 | -.188 | -.250 |
| 25 | 0.000 | -.312 | -.156 | -.094 |
| 50 | -.125 | 0.000 | -.250 | -.250 |
| 75 | -.312 | 0.000 | -.188 | -.312 |
| 100 | 0.000 | -.375 | -.250 | -.063 |
| 125 | -.188 | 0.000 | -.125 | -.375 |
| 150 | -.250 | -.312 | -.063 | -.063 |
| Average | -.147 | -.165 | -.174 | -.201 |

[1] A minus denotes that nails moved opposite from direction of traffic.

## Movement of Control Points

The alignment of the outside wheelpath nails were measured during the fifth month following construction. These measurements, given in Table 2, indicated that the forces exerted on the pavement during the acceleration of vehicles are greater than the braking forces of the vehicles. This is explained by the fact that only the drive wheels accelerate the vehicle, while the braking force of a vehicle is distributed to the pavement by all wheels.

Subsequent measurements of these nails were made at various intervals of time during the 30 months of service following construction. These measurements showed negligible movement after 5 months of service.

## SUMMARY AND CONCLUSIONS

The welded wire fabric reinforcement was furnished from the manufacturer with one edge longer than the other. This longer edge prevented the fabric from laying flat against the pavement and as a result construction was difficult and the rate of placing the surface course was reduced considerably. Cracking of the pavement usually occurred over this longer edge of the fabric. The fact that more pavement cracking occurred at the Tyler Street section than at the Pearce Street section can be attributed to the fact that more effort was made to alleviate the bulging of the longer edge of fabric within the Pearce Street section.

Although pavement cracking is undesirable, some fine cracks which were noted shortly after construction closed under the kneading action of traffic, indicating that all cracks are not necessarily damaging to the pavement. However, the seepage of water and dust into the cracked pavement prevented the possibility of other cracks closing.

Despite the undesirable pavement cracking in the sections with the fabric, these reinforced sections showed little distortion in comparison to the sections without the fabric. If, however, the welded wire fabric reinforcement is to be used successfully beneath a $1\frac{1}{2}$-in. asphaltic concrete surface course, it must lay flat.

## REFERENCES


1. Bransford, T.L., Research and In-Service Training Engineer, Florida State Road Department, Letter to Mr. A.C. Church (June 13, 1957).
2. "Standard Specifications for Roads and Bridge Construction, Section 233." Florida State Road Department (1959).
3. Howard, E.M., "Welded Wire Fabric Reinforcement in Asphaltic Concrete Overlays." ARBA Tech. Bull. 238 (1959).

## II. Reflection Cracking in Asphaltic Concrete Overlays Placed on Old Portland Cement Concrete Pavements

● IN RECENT YEARS it has become necessary to widen and resurface many existing rigid pavements in Florida. This rehabilitation becomes necessary because of the inadequate width of pavements and/or the physical deterioration of the concrete. Widening of existing rigid pavements has been accomplished with both flexible and rigid types of widening strips. In some instances, these widening strips have been constructed entirely along one edge of the existing pavement and in other instances have been constructed adjacent to both edges of the existing pavement. After the widening strips have been constructed, a bituminous surface course is placed over the full width of the pavement to restore smoothness and improve the riding quality. This method of rehabilitating old rigid pavements has proven satisfactory and economical in most instances.

After a short period of time, however, a phenomenon known as "reflection cracking" usually occurs. These cracks develop directly over the joints and cracks in the underlying rigid pavement and also directly over the longitudinal joint between the widening strips and the old pavement.

Reflection cracking has been attributed to differential vertical or horizontal movements at joints, cracks, and pavement edges of the underlying rigid pavement (1). The horizontal movement of slabs is the result of thermal expansion and contraction of the concrete. Vertical movement may be caused by excessive deflection under loads (slab rocking), by differential settlement of adjacent slabs and widening strips, or by curling or warping of the slab due to temperature or moisture gradients within the slab.

Throughout Florida where bituminous overlays have been placed over existing rigid pavements, reflection cracking is almost always evident. These cracks produce an unsightly road, and widen and deepen with time so as to cause "thumping" for the motoring public. They also shorten the life of the overlay because water seepage through these cracks weakens the subgrade. The maintenance of pavements with these reflected cracks is a special problem.

A number of methods have been used by other states to prevent or reduce reflection cracking with varying degrees of success. One of the more recent methods reported to be most promising (2, 3, 4) involves the use of welded wire reinforcement in bituminous overlay. Such reinforcement is intended to eliminate cracking by distributing the stresses caused by the movement occurring at cracks and joints, so that the stress at any one point in the overlay is insufficient to cause the bituminous overlay material to crack.

A method that has been used in Florida for controlling deflection cracking is the breaking of the old pavement into relatively small pieces, with a maximum dimension of approximately 3 ft. The intent is to reduce the magnitude of joint movements by eliminating the cumulative effect of the larger slabs. However, no systematic follow-up of the performance of this procedure has been made.

Increasing the thickness of the bituminous overlay was also suggested as being effective in reducing the incidence of reflection cracking inasmuch as it is intuitively evident that a thicker overlay would offer more resistance to the forces introduced by any given magnitude of slab movement.

In the spring of 1959 the widening and resurfacing of a portland cement concrete pavement north of Lake City offered an opportunity to evaluate these methods of controlling reflection cracking. Advantage was taken of this opportunity to set up a research program to evaluate the effect that (a) welded wire fabric reinforcement, (b) breaking of the existing rigid pavement, and (c) increasing of the bituminous surface course thickness had on preventing or reducing the incidence of reflection cracking in asphaltic concrete overlays placed on an old portland cement concrete pavement.

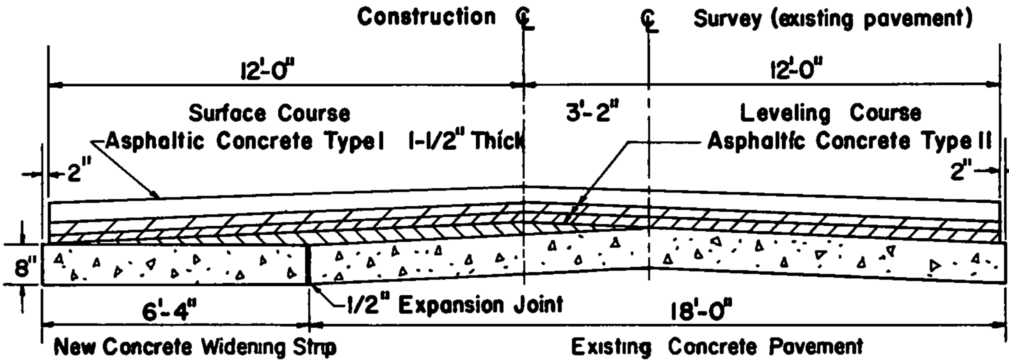



Figure 1. Typical transverse section of roadway at test section I.

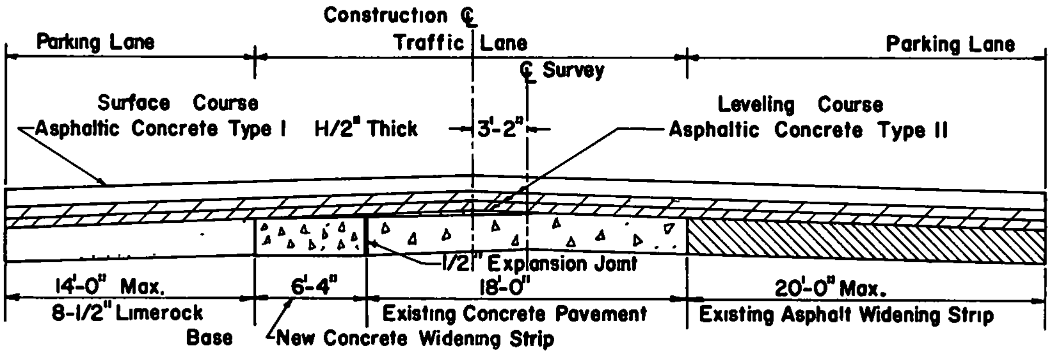



Figure 2. Typical transverse section of roadway at test section II.

## SCOPE

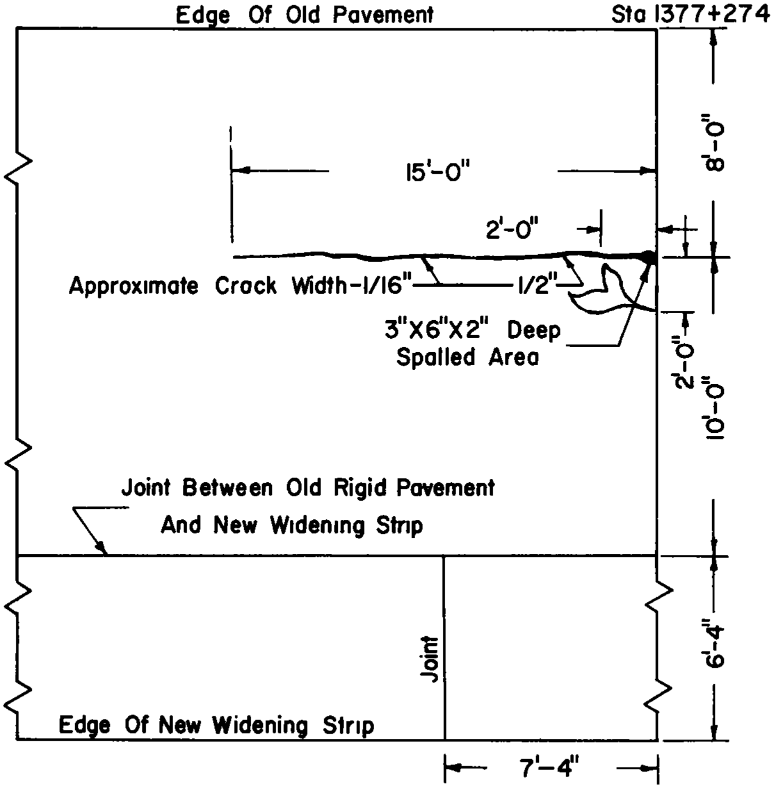
Two test sections were selected north of Lake City on US 41 where an existing 18-ft portland cement concrete pavement was to be rehabilitated by the addition of widening strips of 8-in. plain concrete to provide a total width of 24 ft 4 in., a type II asphaltic concrete leveling course and a type I asphaltic concrete surface course.

### Test Section I

The schedule for test section I included the placement of 200 ft of 3 x 6 - 10/10 welded wire fabric reinforcement placed continuously over the full width of the pavement, a 400-ft section where the existing pavement and the newly constructed widening strip were both broken, and a 200-ft section of pavement with an additional 1 in. of bituminous overlay. This increase in thickness was equivalent in cost per square yard to the use of the welded wire fabric. On the remainder of the project, the old concrete pavement was broken, except that the widening strip was left intact. Figure 1 shows a typical section of the roadway at this test section.

### Test Section II

Test section II is located near a truck inspection station where, in addition to the 6-ft 4-in. rigid widening strip, two flexible widening strips (one on each side of the rigid pavement) were constructed to provide deceleration and storage lanes for trucks being inspected. Figure 2 shows a typical section of the roadway at this test section.



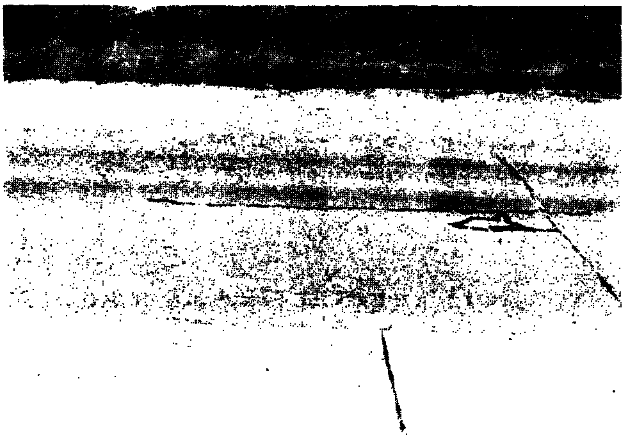



Figure 3. Plan view (upper) and photograph (lower) of typical section of pavement.

Two 250- by 5-ft sections of 3 x 6 - 10/10 welded wire fabric reinforcement were centered over the longitudinal joints of the widening strips, and 6 sheets of 6 x 3 - 10/10 welded wire fabric reinforcement were centered over selected transverse joints in the existing rigid pavement. The original pavement was not broken in this section.

## Pavement Condition Survey

Before resurfacing, a detailed pavement condition survey was made of the existing concrete pavement and the new concrete widening strip in the two test sections. Included in this survey was the location and magnitude of all cracks, spalled area, joints, and patches. A photograph was also made of each slab included in this survey (Fig. 3).

# PROCEDURE

All fabric was placed immediately below the 1½-in., type I asphaltic concrete surface course with the transverse wires down. The 6-in. spaced wires were placed at right angles to the centerline of the pavement and the 3-in. spaced wires were placed parallel to the centerline.

Construction procedures were in accordance with the recommended practices suggested by the Wire Reinforcement Institute (4) with the exceptions that (a) the recommended 1¾-in. minimum overlay was reduced to 1½ in. because this is the maximum normal thickness used by the Florida State Road Department; (b) the leading end of the welded wire fabric was not anchored in test section I due to construction difficulties; and (c) the leading ends of the sheets used in test section II were not all anchored.

A hold-down device was attached to the finishing machine to keep the fabric flat against the underlying pavement and to prevent any entanglement of the fabric with the spreader screw. Figure 2, Part I, of this report illustrates a hold-down device typical of the one used for this experiment. The hold-down device consisted of runners on the outside of each "cat" track and a sled between the "cat" tracks. The runner and sled were secured to the front end of the finisher by chains (see Fig. 3, Part I).

Tension was applied to the fabric by means of J-hooks spaced 12 in. apart and a bridle fabricated from a piece of pipe and three sections of chain (see Fig. 4, Part I). A crimping tool (see Fig. 6, Part I) was used to eliminate any bulging in the fabric which prevented it from laying flat against the underlying pavement.

## Test Section I

The fabric used in test section I was delivered in rolls measuring 11 ft 9 in. in width and 100 ft in length. When the first roll of fabric was unrolled onto the pavement, it was noted that only the center of the fabric would lay flat and a series of humps developed along the edges. This resulted from both edges of the fabric being longer than the center portion. It was intended to place four rolls to reinforce both traffic lanes for 200 ft; but because of the difficulty in paving over the uneven fabric, this part of the experiment was discontinued after only 54 ft was placed in one lane.

An attempt was made to secure the starting end of the fabric to the leveling course with 1½-in. staples, but because the fabric had a tendency to "recoil," the staples would not hold to it. The "recoil" probably would not have occurred except for the fact that the fabric was rolled on a 10-in. mandril during the manufacturing process. Others have reported no difficulty with wire rolled in a similar manner but on a 20-in. mandril. No attempt was made to anchor the cut-off end of the fabric.

The existing pavement and new widening strip was broken between Station 1369+00 and Station 1372+89 by dropping a 2,700-lb weight approximately 8 to 10 ft. The resurfacing thickness was increased by 1 in. between Station 1372+89 and Station 1374+91 with the extra thickness being a type II asphaltic concrete placed with the leveling courses. A 100-ft transition between the standard thickness and the increased thickness was constructed at both ends of this section. The pavement was broken in the transition from Station 1371+89 to Station 1372+89 and this section is included in the evaluation of the effect that breaking the existing rigid pavement has on reflection cracking. The transition between Station 1374+89 and Station 1375+89 was not broken. A plan view of test sections is shown in Figure 4.

## Test Section II

Rolls of fabric measuring 125 ft in length and 5 ft in width were used to reinforce the overlay over the longitudinal joints between the cement concrete widening strip and the

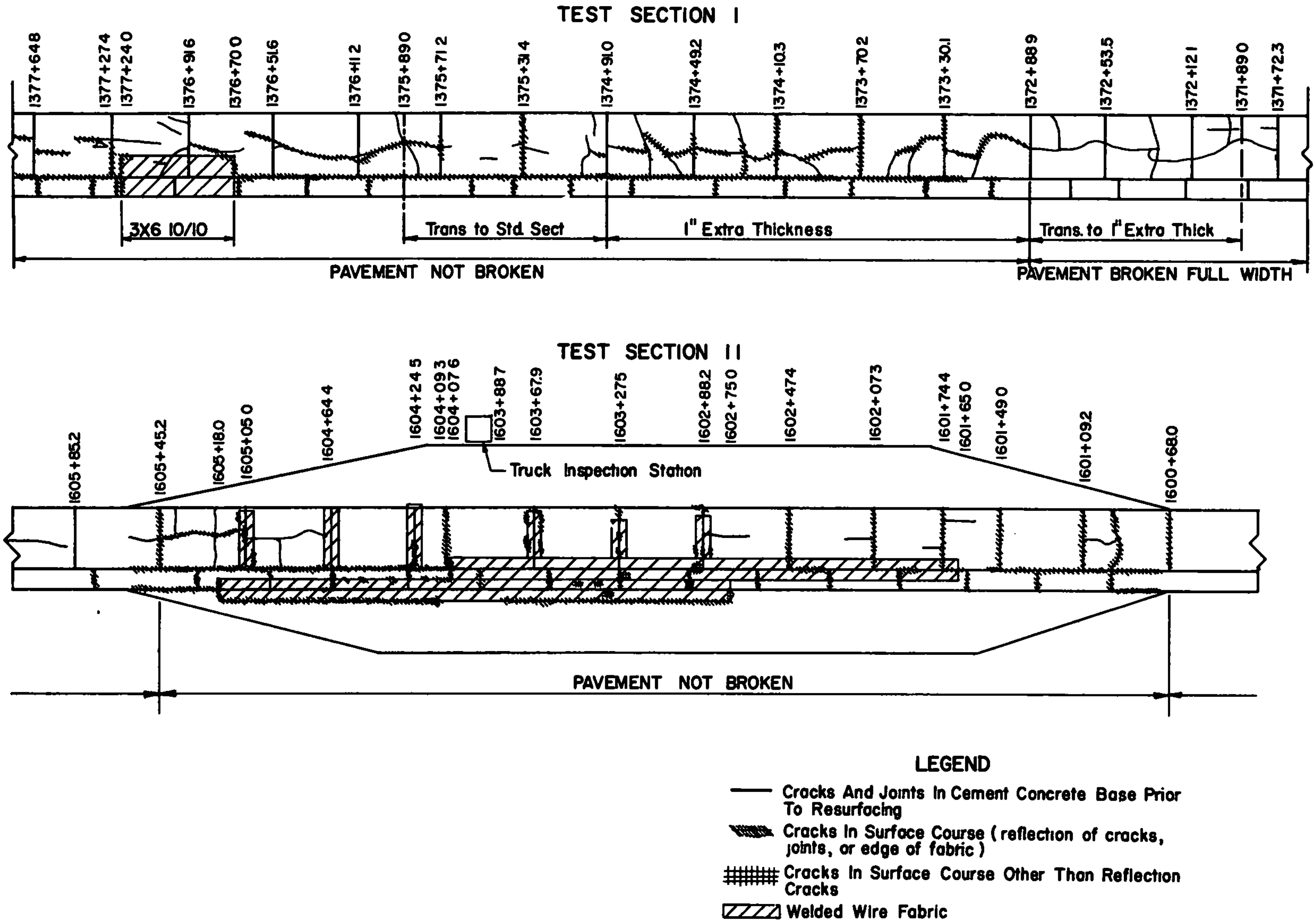



Figure 4. Plan view of test sections.

existing cement concrete pavement, and between the cement concrete widening strip and the limerock base storage lane. The fabric was rolled by the manufacturer with the transverse wires out (away from the center of roll). This allowed the transverse wires to be placed down by merely unrolling the fabric. The leading end of the fabric was secured to the pavement by setting anchors in the concrete and wiring these anchors to the fabric. Where the fabric was anchored over the limerock base, a 3- by 3-in. plate of 20-gage metal was placed over the fabric and a nail 8 in. in length and ¼ in. in diameter was driven through a hole in the plate and into the limerock base.

Two rolls were used at a time to reinforce a strip 250 ft long. As the fabric was unrolled, it would not lay flat due to bulges along one edge. Figure 5 shows the bulging of one strip of fabric and Figure 6 shows this same strip after the surface course had been placed over one-half of it and the bulges were removed by crimping. At first the adjoining ends of the 125-ft rolls were lapped with the trailing end of the first roll placed over the leading end of the second roll. The "recoil" tendency of the fabric caused the lapped end to push up through the fresh surface course as can be seen in the center of Figure 6. This was remedied by wiring the lapped ends of the rolls together.

The trailing ends of the two strips placed were not anchored during construction with the result that they pushed up through the surface course. On the day following construction they were anchored to the concrete base and the surface course repaired.

Six sheets of fabric 8 ft in width and varying in length from 13 to 17½ ft were centered over selected transverse joints and no trouble was encountered while paving over them because the sheets laid flat against the pavement. The leading edge of one sheet had to be secured to the pavement when several medium speed vehicles passed over it slightly distorting the leading edge. Staples of 1½ in. were used and worked very satisfactorily. These were the same staples used in the attempt to secure the roll of fabric placed in test section I indicating that anchoring is simplified when the fabric is in sheets, and there is no tendency to recoil. A plan view of test section II is shown in Figure 4.

## RESULTS

### Effect of Pavement Breaking

After 30 months of service, only a few cracks have occurred where the underlying concrete pavement was broken full width. These cracks do not appear to be related to the original cracks in the cement concrete pavement. Observations made throughout this entire project reveal that, where the cement concrete widening strip was not broken, practically all transverse joints within this widening strip have reflected through the bituminous concrete overlay, and no reflected cracking was noted where the existing pavement was broken. This indicates that reflection cracking has been controlled thus far by breaking the rigid pavement. However, it should be pointed out that, by breaking the existing rigid pavement, the structural value of the cement concrete base, as a rigid pavement, has been destroyed; unless the subbase is firm, there is the possibility of vertical movement between the fragments. Only time will tell if any such adverse effect will occur from breaking the concrete.

### Effect of Increasing the Pavement Thickness

Figure 4 shows that the 1-in. extra pavement thickness has not retarded reflection cracking. This indicates that an extra pavement thickness of 1 in. is unwarranted for the purpose of controlling reflection cracking.

To further investigate the effect that thickness has on reflection cracking, 19 cores were taken from a bituminous concrete overlay in a section of roadway which had been widened and resurfaced about five years earlier. The cores were taken over the longitudinal joint between the old rigid pavement and the rigid widening strip from areas that had varying magnitudes of reflected cracks. The results of these cores showed that for an equal amount of overlay, cracks had occurred in some areas and had not occurred in other areas. This indicates that, if there is a relationship between overlay thickness and incidence of reflection cracking, it varies with the magnitude of displacement occurring at each joint or crack.

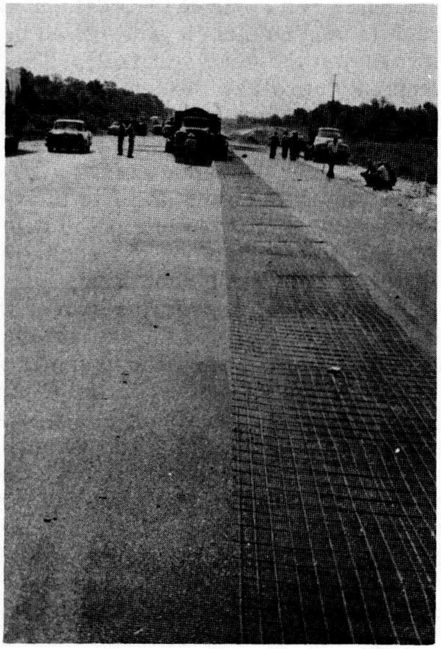


Figure 5. Strip of fabric reinforcement in proper position before placement of surface course; bulging along edge of fabric nearest edge of pavement.

Figure 6. Same strip of fabric (Fig. 5) after surface course has been placed over one-half of it. Practically all bulges have been removed by crimping; evidence of cracking in the fresh surface course seen near exposed fabric in foreground. Note end of strip protruding through the surface course in center of photograph.

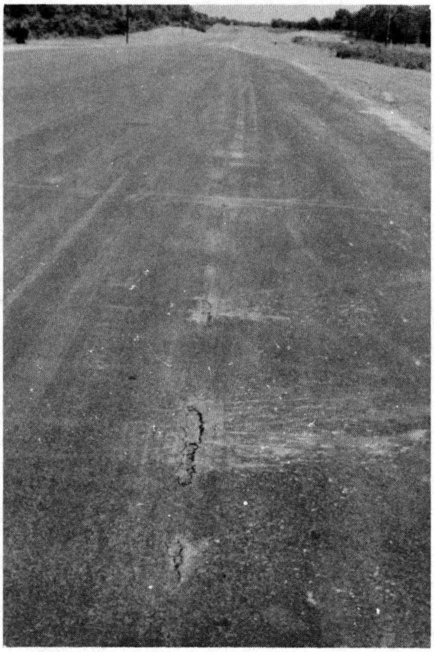


Figure 7. Same area as shown in Figures 5 and 6. A double crack over edge of fabric nearest outside edge of pavement has permitted water and dust to seep in; traffic passing over cracks has splashed water and dust onto surrounding pavement discoloring it.

Effect of Wire Reinforcing

The 54 ft of reinforced overlay in test section I has no reflected cracks within the area of reinforcing. However, Figure 4 shows that cracking has occurred over the edge of fabric in some areas. Despite the limited area that is reinforced, the fabric appears to be controlling or at least retarding the reflection cracking in this area. This is particularly true for the longitudinal joint between the widening strip and the old pavement. Also, the only transverse joint in the widening strip of test section I which has not reflected through the overlay is within this reinforced section.

The bituminous concrete overlay in test section II began cracking in the area of the strips within 24 hr after construction primarily because of the bulging of the longer edge of the fabric over the limerock base has cracked almost the full length of the strip (Fig. 7). This is the same strip of fabric shown in Figures 5 and 6, and Figure 6 shows that the exposed fabric has been crimped to lay flat. Figure 7 shows this reinforced area one week after construction and illustrates the cracking that had occurred along the outside edge of this strip of fabric at this time. Figure 7 also shows that water and dust is seeping into the cracked pavement.

In the area of the strips nearly all of the transverse joints of the new cement concrete widening strip have reflected through the overlay. The longitudinal joint between the old rigid pavement and new widening strip has also reflected through the overlay in some areas. However, the strips appear to have reduced the reflection of the longitudinal joint between the old pavement and new widening strip. The sheets have caused cracking in the overlay primarily over their edges and evidence of cracks over the old transverse joints has been noted.

TABLE 1

TOTAL REFLECTION OF CRACKS AND JOINTS AFTER 30 MONTHS OF SERVICE, TEST SECTION I (Reinforced)[1]

| Width of Crack (in.) | Transverse | | | | | | | | | Longitudinal | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Transverse Joints (ft) | | Widening Strip Joints (ft) | | Original Pavement (ft) | | Total (ft) | | Reflected Cracks (%) | Joint Betw. Conc. Pvt. & Widening Strip (ft) | | Original Pavement (ft) | | Total (ft) | | Reflected Cracks (%) |
| | Orig.[2] | Ref.[3] | Orig. | Ref. | Orig. | Ref. | Orig. | Ref. | | Orig. | Ref. | Orig. | Ref. | Orig. | Ref. | |
| <1/16 | - | - | - | - | 4.0 | 0.0 | 4.0 | 0.0 | 0.0 | - | - | - | - | - | - | - |
| 1/16 | - | - | - | - | 5.0 | 0.0 | 5.0 | 0.0 | 0.0 | - | - | 5.5 | 0.0 | 5.5 | 0.0 | 0.0 |
| 1/8 | - | - | - | - | - | - | - | - | - | - | - | 9.0 | 0.0 | 9.0 | 0.0 | 0.0 |
| 3/16 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1/4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 5/16 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 3/8 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1/2 | - | - | 6.3 | 0.0 | - | - | 6.3 | 0.0 | 0.0 | 49.0 | 0.0 | - | - | 49.0 | 0.0 | 0.0 |
| 3/4 | 5.2 | 0.0 | - | - | - | - | 5.2 | 0.0 | 0.0 | - | - | - | - | - | - | - |

[1]Twenty ft of induced cracking occurred over the edge of the wire fabric, representing 15.2 percent of the perimeter of the wire.
[2]Total number of lineal feet of joint or crack in original portland cement concrete pavement.
[3]Total number of lineal feet of cracks reflected through the bituminous overlay.

TABLE 2

TOTAL REFLECTION OF CRACKS AND JOINTS AFTER 30 MONTHS OF SERVICE, TEST SECTION I (Nonreinforced)

| Width of Crack (in.) | Transverse | | | | | | | | | Longitudinal | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Transverse Joints (ft) | | Widening Strip Joints (ft) | | Original Pavement (ft) | | Total (ft) | | Reflected Cracks (%) | Joint Betw. Conc. Pvt. & Widening Strip (ft) | | Original Pavement (ft) | | Total (ft) | | Reflected Cracks (%) |
| | Orig.[1] | Ref.[2] | Orig. | Ref. | Orig. | Ref. | Orig. | Ref. | | Orig. | Ref. | Orig. | Ref. | Orig. | Ref. | |
| <1/16 | - | - | - | - | 4.0 | 0.0 | 4.0 | 0.0 | 0.0 | - | - | 81.7 | 11.5 | 81.7 | 11.5 | 14.1 |
| 1/16 | - | - | - | - | 35.9 | 0.0 | 35.9 | 0.0 | 0.0 | - | - | 186.8 | 143.0 | 186.8 | 143.0 | 76.6 |
| 1/8 | - | - | - | - | 72.5 | 6.0 | 72.5 | 6.0 | 8.2 | - | - | 156.0 | 129.0 | 156.0 | 129.0 | 82.7 |
| 3/16 | - | - | - | - | 13.5 | 2.5 | 13.5 | 2.5 | 18.5 | - | - | 95.1 | 69.5 | 95.1 | 69.5 | 73.1 |
| 1/4 | - | - | - | - | 27.6 | 6.0 | 27.6 | 6.0 | 21.7 | - | - | 132.8 | 51.0 | 132.8 | 51.0 | 38.4 |
| 5/16 | - | - | - | - | - | - | - | - | - | - | - | 5.5 | 5.5 | 5.5 | 5.5 | 100.0 |
| 3/8 | - | - | - | - | - | - | - | - | - | - | - | 27.8 | 22.8 | 27.8 | 22.8 | 82.0 |
| 1/2 | - | - | 139.0 | 135.0 | - | - | 139.0 | 135.0 | 97.1 | 687.0 | 487.5 | 21.0 | 15.0 | 708.0 | 502.3 | 70.9 |
| 3/4 | 342.0 | 102.0 | - | - | - | - | 342.0 | 102.0 | 29.8 | - | - | 7.5 | 7.5 | 7.5 | 7.5 | 100.0 |

[1]Total number of lineal feet of joint or crack in original portland cement concrete pavement.
[2]Total number of lineal feet of cracks reflected through the bituminous overlay.

## SUMMARY AND CONCLUSIONS

Welded wire fabric reinforcement, as used in this project, has been partially successful in controlling reflection cracking. The larger reinforced area of test section I has, after 30 months, prevented longitudinal and transverse joints from reflecting through the overlay. The sheet reinforcement used in test section II has been effective in reducing the reflection of transverse joints. The strip reinforcement has been effec-

TABLE 3

TOTAL REFLECTION OF CRACKS AND JOINTS AFTER 30 MONTHS OF SERVICE, TEST SECTION II (Reinforced)[1]

| Width of Crack (in.) | Transverse | | | | | | | | | Longitudinal | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Transverse Joints (ft) | | Widening Strip Joints (ft) | | Original Pavement (ft) | | Total (ft) | | Reflected Cracks (%) | Joint Betw. Conc. Pvt. & Widening Strip (ft) | | Original Pavement (ft) | | Total (ft) | | Reflected Cracks (%) |
| | Orig.[2] | Ref.[3] | Orig. | Ref. | Orig. | Ref. | Orig. | Ref. | | Orig. | Ref. | Orig. | Ref. | Orig. | Ref. | |
| <1/16 | - | - | - | - | - | - | - | - | - | - | - | 7.5 | 0.0 | 7.5 | 0.0 | 0.0 |
| 1/16 | - | - | - | - | - | - | - | - | - | - | - | 12.0 | 0.0 | 12.0 | 0.0 | 0.0 |
| 1/8 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1/4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1/2 | - | - | 40.2 | 27.6 | - | - | 40.2 | 27.6 | 68.7 | 484.0 | 22.0 | - | - | 484.0 | 22.0 | 4.5[4] |
| 3/4 | 107.3 | 18.0 | - | - | - | - | 107.3 | 18.0 | 16.8 | - | - | - | - | - | - | - |

[1] 291.0 feet of induced cracking occurred over the edges of the wire fabric, representing 22.3 percent of the perimeter of the wire.
[2] Total number of lineal feet of joints or cracks in original portland cement concrete pavement.
[3] Total number of lineal feet of cracks reflected through the bituminous overlay.
[4] 9.1 percent of reflection of longitudinal joint between old rigid pavement and new portland cement concrete widening strip.

TABLE 4

TOTAL REFLECTION OF CRACKS AND JOINTS AFTER 30 MONTHS OF SERVICE, TEST SECTION II (Nonreinforced)

| Width of Crack (in.) | Transverse | | | | | | | | | Longitudinal | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Transverse Joints (ft) | | Widening Strip Joints (ft) | | Original Pavement (ft) | | Total (ft) | | Reflected Cracks (%) | Joint Betw. Conc. Pvt. & Widening Strip (ft) | | Original Pavement (ft) | | Total (ft) | | Reflected Cracks (%) |
| | Orig.[1] | Ref.[2] | Orig. | Ref. | Orig. | Ref. | Orig. | Ref | | Orig. | Ref. | Orig. | Ref. | Orig. | Ref. | |
| <1/16 | - | - | - | - | 31.5 | 0.0 | 31.5 | 0.0 | 0.0 | - | - | 100.8 | 21.0 | 100.8 | 21.0 | 20.8 |
| 1/16 | - | - | - | - | 14 0 | 8.0 | 14.0 | 8.0 | 57.1 | - | - | 30.5 | 0.0 | 30.5 | 0.0 | 0.0 |
| 1/8 | - | - | - | - | 21.0 | 10.0 | 21.0 | 10.0 | 47.6 | - | - | 13.5 | 0.0 | 13.5 | 0.0 | 0.0 |
| 1/4 | - | - | - | - | - | - | - | - | - | - | - | 13.0 | 13.0 | 13.0 | 13.0 | 100.0 |
| 1/2 | - | - | 60.6 | 57 9 | - | - | 60.6 | 57.9 | 95.5 | - | - | - | - | - | - | - |
| 3/4 | 172.5 | 136.5 | - | - | - | - | 172.5 | 136 5 | 79.1 | 555.9 | 260.0 | - | - | 555.9 | 260.0 | 46.7 |

[1] Total number of lineal feet of joints or cracks in original portland cement concrete pavement.
[2] Total number of lineal feet of cracks reflected through the bituminous overlay.

tive in reducing the longitudinal joints from reflecting through the overlay, but has not prevented the transverse joints in the new widening strip from reflecting through the overlay.

Placement of the sheets was less difficult than the placement of the rolls of fabric. Also, the use of rolls cannot be considered practical unless they lay relatively flat against the pavement when first unrolled.

Increasing the bituminous overlay by 1 in. has not prevented or retarded reflection cracking.

Breaking of the existing rigid pavement has prevented the reflection of original cracks and joints. Only a few cracks were noted where the pavement was broken. In all cases these cracks were fine in magnitude and short in length.

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